PET-CT in Head and Neck Cancer

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Malignancies in the Head & Neck Region

Soft tissue neoplasms in:

- Lip
- Paranasal tumors (maxillary & ethmoid sinus)
- Oral cavity
- Oropharynx
- Nasopharynx
- Hypopharynx
- Larynx
- Salivary gland
- Mucosal melanoma

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PET/CT Assessment of Head & Neck Malignancies
Lecture Outline

- Clinical data
- FDG protocols & indications
- FDG for staging - special emphasis on N- & T-
- FDG for treatment planning & monitoring
- FDG – prognostic value
- FDG for surveillance and dg. of recurrence
- Second primary tumors
- Metastatic tumor with unknown primary
- PET/CT – the use of additional tracers
- PET/MR
Head & Neck Tumors
Incidence & Etiology

- 6th most common cancer worldwide
- Men/women risk ratio: 2/1
- Greatest burden: low- and medium-income countries
- Histology: >90% squamous cell Ca & adenoCa
- Survival: decreases significantly from early (80%) to locally advanced disease (40%)
- Etiology:
  - Common - tobacco & alcohol (>75% cases)
  - Epstein–Barr (EBV, nasopharynx ca) & Human papillomavirus (HPV, ~ 50% oropharynx ca)
- Characteristics
  - Biological complexity
  - Invasion (potentially) of multiple structures
Head & Neck Tumors
Symptoms & Diagnosis

Clinical signs:
- Early nonspecific: sore throat, difficult swallowing, hoarseness
- Late: mass, pain, dysphagia, partial airway obstruction, foreign body sensation, cranial neuropathy, trismus

Diagnostic tools for assessment:
- Physical examination
- Endoscopy
- Laboratory tests
- X-rays
- CT
- MRI
- Biopsy
- FNA
- [FDG-]PET/CT
FDG-PET/CT in the Assessment of H&N Malignancies

Main Indications:

- Initial staging (N&M): nodal & distant disease
- Defining the prognosis (presence & degree of metabolic activity)
- Treatment planning
- Assessing treatment response
- Diagnosis of recurrence and restaging
- Identify the primary lesion
FDG-PET/CT in Head & Neck Tumors
Patient Preparation & Imaging Protocol

- Fast 4 - 6 hrs.
- Good hydration
- Glucose levels <150

- FDG dose: 10-15 mCi
- Uptake phase: 60-90 min
- **No talk, drink & chew**

**Imaging:**
- Head fixation
- Head (top-of-the-ear) to mid-thigh
- Both PET & CT are Head-to-Thigh or 2 separate acquisitions

**I.V. contrast**
- Easier definition of vessels & separation from nodes
- Care for PET attenuation correction artifacts
Staging of Head & Neck Tumors

- T:
  - Size & subsite involvement
  - T1-3: increasing size
  - T4: invasion of surrounding structures

- N:
  - Size & number of LNs
  - Relationship to primary tumor (ipsi-/contra-lateral)

- M - distant mets
  - Bone in nasopharyngeal ca
  - Lungs (other H&N tumors)
FDG-PET/CT for T-Staging
Nasopharynx Ca with Extension to Base of Skull

Role of FDG-PET/CT for T-staging
- Limited value, less anatomy detail vs. MRI
- MRI required for planning surgery & radiotherapy
N- Staging & Assessment of LN Involvement in H&N Malignancies

Early & accurate: critical for selection of appropriate treatment strategy

CT criteria
- Shape, size, density, contrast enhancement
- Variable normal size
  - head & neck: 10 mm (vs. mesenteric <7mm; inguinal 15mm)
  - ~ 20% of normal size LNs – malignant
  - ~40% of enlarged LNs – benign

FDG imaging
- FDG: similar/higher detection rates of LN staging vs. conventional imaging
LN groups & levels I-VI in the H&N region

Courtesy, EORTC Task Force
# LN Drainage of H&N Malignancies

<table>
<thead>
<tr>
<th>Region</th>
<th>LN drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lip (upper &amp; lower)</td>
<td>Submandibular, submental, subdigastric</td>
</tr>
<tr>
<td>Oral cavity</td>
<td>Subdigastric, upper jugular, submandibular</td>
</tr>
<tr>
<td>Oropharynx ((tongue, tonsillar, parapharyngeal)</td>
<td>Upper, middle &amp; deep cervical, subdigastric, para- &amp; retro-pharyngeal</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>Retropharyngeal, deep cervical</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>Mid- &amp; posterior cervical triangle, para-tracheal</td>
</tr>
<tr>
<td>Larynx (vocal cords, supra- &amp; sub-glottis)</td>
<td>Subdigastric, mid-internal &amp; inferior jugular</td>
</tr>
<tr>
<td>Paranasal (nasal fossa, frontal, ethmoidal, maxillary, sphenoid sinuses)</td>
<td>Submaxillary, base of skull, subdigastric, submandibular, jugulo-digastric</td>
</tr>
<tr>
<td>Salivary glands (parotid, submaxillary)</td>
<td>Preauricular, jugulo-digastric, intraglandular, submental</td>
</tr>
</tbody>
</table>
FDG-PET/CT for Assessment of LN Involvement in H&N Malignancies

Provides relevant information

- Number of nodes: single/multiple
- Distribution: ipsi-/contra-/bi-lateral
- Size
- Location: anatomic levels I-VI

- Incremental synergistic data of PET/CT
  - Metabolic (FDG): involvement of normal size nodes
  - Anatomic (CT): presence of nodal mets adjacent to highly FDG-avid primary tumors
FDG-PET/CT for N- Staging
Nasopharynx Ca with multiple LN mets
FDG Imaging for Nodal Staging in H&N Malignancies

<table>
<thead>
<tr>
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<th>Sensitivity</th>
<th>Specificity</th>
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<tr>
<td>FDG (per patient)</td>
<td>84-91%</td>
<td>84-87%</td>
</tr>
<tr>
<td>FDG (per neck level)</td>
<td>80-84%</td>
<td>96%</td>
</tr>
<tr>
<td>CT/MRI</td>
<td>63%</td>
<td>96%</td>
</tr>
</tbody>
</table>

Sun et al, Oral Oncol, 2015
Meta-analysis, 24 studies, >1,250 pts

Yongkui et al, Surg Oncol, 2013
Meta-analysis, 14 studies, >750 pts

© Kyzas et al, Metaanalysis, JNCI 2008
FDG-PET/CT
N- Staging in H&N Malignancies

- **Prognostic significance** *(Schoeder et al., J Nucl Med, 2006)*
  5-yr **DFS** decreases from 55% to 35% with LN involvement

- **NO** (by clinical and conventional imaging) – challenge
  - 10-45% probability to be N+ at surgery
  - If likelihood of occult neck mets of SCC is ≥ 20%, elective neck dissection is recommended
  - **Negative FDG does not allow to avoid treating an NO neck**
FDG PET/CT for M-Staging in H&N Malignancies

The Value of Whole Body Imaging

- Incidence of distant mets: 7-25%, up to 70% in stage III & IV
- Incidence of synchronous malignancy: 10%
- Prognostic significance of distant mets

- Pre-treatment FDG study should be performed mainly in advanced H&N tumors

©Scott et al, JNM 2008
FDG-PET/CT for M Staging
Ca of Rt. Mandible, Cervical LNs, Liver & Bone Mets
FDG-PET/CT for M-staging in H&N Tumors

- Diagnosis of previously unrecognized distant mets: 10-17% patients
- Very high NPV for distant mets (>5mm diameter)
- Sensitivity of FDG PET/CT > CT or MRI alone

Xu et al, Head Neck 2011, metaanalysis, 12 studies
- sensitivity 88%, specificity 95%
2nd Primary Tumors (Synchronous or Metachronous)

- Risk for 2nd primary neoplasms:
  - Synchronous – within 6 months: 1.4 – 18%
  - Metachronous – after 6 months, within 5 years: >20%

- Location:
  - 40% larynx or pharynx
  - 31% lung
  - 9% esophagus

- Performance indices of FDG-PET/CT:
  sensitivity: 87%, specificity 95%
Larynx Ca & 2nd Metachronous Primary Tumor in Esophagus

No FDG uptake in vocal cord

FDG+ focus in anterior neck localized to proximal esophagus

Larynx Ca, 18 mo. NED, onset of hoarseness & swelling rt. vocal cord (CT); suspected recurrence
Ca of Lt. Parotid & Metachronous 2\textsuperscript{nd} Primary Tumor in Lt. Lung

7/2012
Ca of Lt. Parotid
Staging, 10/2012

3/2013
Surveillance after CRT & Surgery
2\textsuperscript{nd} primary tumor Lt. Lung
## Treatment of H&N Cancer

guided by site, stage, pathologic findings

- **Surgery**
- **Radiation (RT):** Intensity-modulated RT – minimized damage to adjacent organs; Brachytherapy (lip, oral cavity cancers)
- **Chemotherapy (CT):** Cisplatin, carboplatin, taxane; rare stand-alone; often combination with RT;
- **Biologic therapy:** EGFRs overexpressed in many H&N tumors (poor prognosis, resistance to RT); combination with CT; cetuximab; matuzumab, panitumumab, gefitinib, erlotinib

- **Single-modality** treatment: surgery or RT, early-stage, localized disease (stage I,II)
- **Combined modality** therapy: local or regionally advanced disease (stage III,IV)
- **Palliation chemotherapy:** metastatic, recurrent disease

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FDG-PET/CT for Treatment Planning in H&N Tumors

- Planning of the *surgical* procedure (<MRI)
- **Radiation** treatment planning based on metabolic & biologic features (image guided & intensity modulated): address target tumor more effective & spare normal tissues:
  - Change in gross tumor volume (GTV)
    - Reduced in 33% & Increased (>25%) in 17% of patients
  - Reduced risk of geographical misses
  - Minimized dose to non-target organs
- PET/CT changed RT planning inducing differences in volumes & doses in ~ 55% patients
- Induction of more aggressive **chemotherapy** regimen
FDG-PET/CT for Treatment Planning in H&N Tumors

M, 58 y, Nasopharynx Ca (cT4)
CT: unilateral right LN involvement
PET/CT: additional left LN - cN2c
RT: Modified boost-PTV (70 Gy) to include lt. LN

CT-based
PET/CT-based
FDG Imaging for Treatment Planning in H&N Tumors
Improves Staging & Management in H&N Squamous Cell Ca

Lonneux et al, JCO 2010, Multicenter prospective, 233 pts

- Discordant FDG & conventional imaging (CI): 43% pts
  - FDG accurate stage change: 20%
  - FDG error rate: 6% (FDG+ inflammatory LN & pneumonia)
- Accuracy: CI & FDG > CI stand-alone
- FDG impact on management:
  - Low: 81%
  - Medium: 5% (intramodality changes)
  - High: 9% (intermodality: curative to palliation & palliation to cure)

Goal of treatment: cure or palliation (depending on disease severity or progression)
FDG-PET/CT in H&N Malignancies
Quantitation & Prognostic Value

Potential role for pre-treatment quantitation for prognosis & prediction of survival
  - No optimal cut-off could be determined

- **SUV**
- **MTV** (metabolic tumor volume) – an index combining SUV & tumor volume (=volume of tumor with increased FDG uptake)

- Pharyngeal Ca: MTV - best predictor of recurrence & DFS
  

- Oropharyngeal SCC: MTV predicted local failure, overall survival & distant mets
  
  *Lim et al, J Nucl Med, 2012*
SUV Quantitation for Grade & Prognosis in H&N Malignancies

SUV & Tumor Grade

©Roh et al, 2007

SUV & Survival

©Scott et al, 2008
FDG-PET/CT in H&N Malignancies
Surveillance & Predicting Neck Status after
Definitive Chemo-Radio-Therapy

- FDG > CT/MRI for detecting residual tumor after chemo-radiation

At 8 - 12 weeks following CRT:
- FDG-PET/CT (± ΔSUV changes):
  - sensitivity 90%, specificity 88% PPV 75%, NPV 95%
  - Negative FDG-PET/CT: reliable, predicts negative LN dissection
  - Positive FDG-PET/CT: DD residual disease vs. inflammation
  - Standardization of uptake that should be defined as residual disease or recurrence!
Defining Response to Treatment in H&N Tumors (morphologic criteria)

- **Complete clinical response (CR)**
  - no visible or palpable neck disease
  - no radiographic findings (e.g. focally abnormal or large, >1.5 cm, LNs)
  - *Complete pathological response (CMR)* requires pathologic confirmation

- **Partial Response (PR)**
  - $\geq 50\%$ (30% linear by RECIST) reduction in tumor size
  - greater reduction in tumor size on 2 perpendicular dimensions

- **Progressive Disease (PD)**
  - appearance of new lesions
  - $\geq 25\%$ (20% by RECIST) increase in size of known lesions

- **Stable Disease (SD)**
  - any reduction in average tumor size <50% (30% by RECIST)
FDG-related “Hopkins Criteria” for Therapy Response Assessment in H&N Tumors

Marcus et al, JNMMI 2014

- Intensity (vs. internal jugular vein & liver)
- Pattern: focal/diffuse

Score system:
- Negative
  - 1: CMR (<vein)
  - 2: likely CMR (vein<focal<liver)
  - 3: likely post-RT inflammation (vein/liver<, diffuse)
- Positive
  - 4: likely residual tumor (focal, >liver)
  - 5: residual tumor (focal, intense)

Specificity 92% NPV 91%
Good interobserver reliability
FDG-PET/CT End-of-Treatment Assessment

Nasopharynx Ca, Equivocal MRI
FDG-PET/CT Residual Tumor
F, 61, SCC Base of Tongue & Cervical LN Mets s/a Chemo & Radiation (IMRT 70 Gy Primary & 50Gy Neck)
FDG-PET/CT 4 month after treatment

Focal FDG uptake – lt. hard palate (border of radiation field)
PET/CT guided biopsy: Recurrent SCC
Additional chemo-radiotherapy
FDG-PET/CT 10 weeks after treatment – Negative
Assessing response - facilitated if pre- and post-treatment FDG-PET/CT studies are available for comparison

Timing of post-treatment study
- After radiotherapy: delay of at least 8-12 weeks to reduce the potential for false positive inflammatory radiation-related reactions.
- After chemotherapy: delay of at least 2 weeks to avoid false negative study results
M, 46, Ca of Floor of Mouth s/a Chemo (cisplatin) & Radiation (2-dimensional) FDG-PET/CT 3 month after treatment

Focal FDG uptake in floor of mouth (center of radiation field) Report: probably inflammatory post-radiation Clinical examination – normal Clinical follow up 12 mo. - NED
Diagnostic Dilemma: Laryngeal Edema Persisting after Radiation

- Recurrence is diagnosed in 50% cases
- Gold standard: laryngeal biopsy - can cause complications & 30% FP rate
- **FDG PET/CT:** sensitivity 92%, specificity 96%
  - **Positive study** can guide biopsy to hypermetabolic focus, decrease sampling error and avoid damage to only edematous regions
  - **Negative study:** can prevent unnecessary biopsy unless there is a high clinical suspicion for recurrence.
FDG-PET/CT in Post-Rx Laryngeal Edema

Larynx Ca, edema, 3 mo. s/p radiotherapy

CT: laryngeal edema (rt. vocal cord & anterior commissure)

FDG avid focus (SUVmax 4.4) in edematous changes at anterior commissure

PET/CT guided biopsy: Squamous Cell Carcinoma
FDG- PET/CT in Persistent Laryngeal Edema

Advanced (T3N1) supraglottic tumor
CT - diffuse supraglottic edema

PET/CT - no FDG uptake in the edematous region
No residual viable tumor
Negative clinical & radiological follow-up: 9 years
FDG Imaging for Long Term Surveillance & Diagnosis of Recurrence of H&N Tumors

Aim of surveillance:

- Diagnosis of residual metabolically active tumor (= refractory patients to be considered for salvage treatment)
- Guiding biopsy of edematous/fibrotic site - identify patients in whom neck dissection might be avoided
- Early detection of recurrence & metachronous 2nd primaries

FDG: highly valuable (after treatment)

- NPV of 2 repeat FDG studies: 98%

Two consecutive negative studies (6 mo. interval) may eliminate routine post-treatment imaging if there is NO clinical suspicion of recurrence
FDG-PET/CT Guiding Diagnosis of Recurrence in H&N Tumor

Advanced retro-molar tumor, s/p resection & reconstruction (9 mo.)

CT - flap & edema in oral cavity
Focal FDG uptake in retro-molar region, underneath flap

Guided biopsy - positive for recurrence
FDG-PET/CT in H&N Malignancies
Diagnosis of Recurrence & Restaging

- CT & MRI: impaired by loss of landmarks and symmetry
- FDG-PET/CT
  - High sensitivity 78-96%, vs. CT/MRI 38-80%
  - High accuracy 81% vs. CT/MRI 45%
- Recurrent tumor in primary site:

<table>
<thead>
<tr>
<th></th>
<th>sensitivity</th>
<th>specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDG-PET/CT</td>
<td>88-100%</td>
<td>75-100%</td>
</tr>
<tr>
<td>CT/MRI</td>
<td>70-92%</td>
<td>50-75%</td>
</tr>
</tbody>
</table>
FDG PET/CT in CUP of the Head & Neck

- 2-9% of squamous cell tumors present with metastatic neck LNs and no primary
- Diagnostic and therapeutic challenge – choice of treatment depends on staging & histology
- Blind non-targeted treatment is debilitating

FDG PET/CT **detectability rate of primary** tumor:
- generally accepted as >30% (range ~30-80%)
  - vs. CT/MRI & random biopsy: 10-20%
- False positive FDG-PET/CT: 16-20% (asymmetric physiologic uptake or uptake in inflammatory/infectious processes)
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>No. Patients</th>
<th>Device</th>
<th>Primary detection</th>
<th>Change in management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braams</td>
<td>1997</td>
<td>13</td>
<td>PET</td>
<td>4 (30%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Aassar</td>
<td>1999</td>
<td>17</td>
<td>PET</td>
<td>9 (53%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Bohulaviski</td>
<td>2000</td>
<td>53</td>
<td>PET</td>
<td>27 (63%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Regelnik</td>
<td>2002</td>
<td>50</td>
<td>PET</td>
<td>16 (32%)</td>
<td>10 (20%)</td>
</tr>
<tr>
<td>Stoeckli</td>
<td>2003</td>
<td>18</td>
<td>PET</td>
<td>5 (28%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Freudenberg</td>
<td>2005</td>
<td>21</td>
<td>PET/CT</td>
<td>12 (57%)</td>
<td>N/A</td>
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<tr>
<td>Nassenstein</td>
<td>2007</td>
<td>39</td>
<td>PET/CT</td>
<td>10 (26%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Paul</td>
<td>2007</td>
<td>14</td>
<td>PET/CT</td>
<td>7 (50%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Wartski</td>
<td>2007</td>
<td>38</td>
<td>PET/CT</td>
<td>13 (34%)</td>
<td>23 (60%)</td>
</tr>
<tr>
<td>Johansen</td>
<td>2008</td>
<td>60</td>
<td>Mixed</td>
<td>18 (30%)</td>
<td>30 (25%)</td>
</tr>
<tr>
<td>Miller</td>
<td>2008</td>
<td>31</td>
<td>PET</td>
<td>9 (29%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Yabuki</td>
<td>2010</td>
<td>24</td>
<td>PET</td>
<td>9 (38%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Rudmik</td>
<td>2011</td>
<td>20</td>
<td>PET/CT</td>
<td>11 (55%)</td>
<td>4 (20%)</td>
</tr>
</tbody>
</table>

FDG Imaging in H&N CUP

13 papers (up to 2012)
6 – PET; 7 – PET/CT
No. patients: 13-60/study

398 patients
detectability rate
primary: 26-63%
SCC: 50-55%

Courtesy Dr. Gad Abikhzer, Rambam
PET/CT in Metastatic Cancer of Unknown Origin
Cervical Lymph Node Positive for SCC

M, 74y, enlarged rt. cervical LN
Histology: metastatic squamous cell ca

FDG-PET/CT : focal uptake in rt. lingual tonsil & right cervical LN
Diagnosis: SCC of rt. lingual tonsil
Retrospectively detected on MRI (?7mm)
Patient referred to chemo-radiation
FDG PET/CT in CUP of the Head & Neck

Patterns:

- Frequent: unilateral, levels II & III
- Rare (5-10%): bilateral, levels I, IV & V

Cervical LN mets:

- Most primary tumors are located in the H&N region
- SCC mets in cervical LN - mainly tonsils, base of tongue
- *can be also distant (e.g. lung, GIT, mainly non-SCC cervical LN)*

Whole body capability of PET/CT:

- Distant primary (lung, GIT)
- Unsuspected additional distant mets (10-20%): mediastinal LNs, lungs, bone
FDG Imaging of H&N Tumors - Pitfalls

Physiologic FDG uptake in the H&N region can either mask or mimic tumors

**False Negative**
- Lesion size <6 mm
- Metabolic rate
- Mis-registration (motion between PET & CT)

**False Positive**
- Asymmetric physiologic uptake
- Inflammation
- Benign lesions
- Salivary gland asymmetry
- Vocal cord paralysis
- Focal muscle uptake (masticatory & sternocleidomastoid; strain or excessive use)
- Metallic implants
FDG-PET/CT – Pitfalls in Head & Neck Region

Physiological asymmetric uptake in rt. vocal cord (due to paralysis of lt. vocal cord)

NSC Lung Ca – Staging, Focal uptake in rt. upper neck
FDG-PET/CT – Pitfalls in Head & Neck Region

FDG Uptake in Infectious Process

M, 67, parotid cas/a left total parotidectomy & radiotherapy (1y)

Focal FDG uptake left maxilla
Diagnosis: **dental abscess**
Warthin’s tumor
78% FDG avidity
PET/CT of H&N Malignancies Using Tracers Beyond FDG

- **18F-MISO** (mizonidazole) – marker of hypoxia
  - Hypoxia is an indicator of poor prognosis
  - Negatively correlated with perfusion
  - May assist in radiotherapy planning (localize areas of hypoxia for dose escalation or boost)

- **18F-FLT** (fluorothymididine) – enhanced uptake during DNA synthesis.
  - Proliferation index for tumor cells
  - For early response assessment (subvolumes with high proliferative activity for dose escalation)

- **11C-Methionine** – index of protein transport & synthesis
  - Index of early response; correlates with end-of-treatment tumor volume reduction

- **11C-choline** – marker of cell membrane synthesis
PET/MRI in H&N Malignancies

- MRI – excellent soft tissue contrast
  - Differentiates masses from neighboring tissues
  - Modality of choice for head and neck imaging
  - Low sensitivity for metastatic LNs – morphologic criteria.
- FDG PET superior sensitivity for cervical LN

- Initial feasibility study (2011):
  - excellent agreement between PET/CT & PET/MR
- Kanda et al, EJR 2013
  - T-staging accuracy: PET/MR 87% vs PET/CT 67%
  - N-staging: similar sensitivity 77%, specificity 96%, accuracy 93%
FDG-PET/MR in SCC of Tongue

M, 55, SCC of tongue

Tumor not detected on MRI (dental artifacts)

FDG-PET shows tumor and LN metastasis

Courtesy Dr. Corina Millo, NIH, USA
PET/MR diagnosis & treatment planning

Supraglottic Paraganglioma

Courtesy Dr. J. Bomanji, UCLH, London
The Opinion of Referring Physicians on the Use of FDG-PET/CT in H&N Tumors

Johnson et al, Laryngoscope 2014

FDG is not indicated:
- When there is no diagnosis of malignancy (only clinical suspicion)
- In pretreatment staging of stage I/II tumors
- In known non-/less- FDG avid malignancies (e.g. Thyroid Ca)

Caution:
- Salivary gland tumors (highly FDG-avid benign lesions)

No good data to demonstrate:
- Therapeutic advantages of early detection of recurrence (by 6-12 mo. to clinical symptoms)
- Improved loco-regional control or DFS using FDG-PET/CT surveillance
Recommend FDG-PET/CT for:

- **Initial staging of seemingly advanced disease** (stage 3 & 4): oral cavity, oro- & hypo-pharyngeal, larynx cancer

- **Distant metastatic work-up**: nasopharyngeal cancer (N2-3 disease), mucosal melanoma

- **Evaluation of CUP** presenting with a neck mass

- **Post-treatment evaluation in patients with NO & clinical suspicion of active disease** (at 12 weeks), further management relies on results of FDG study; if negative optional to proceed with further cross-sectional imaging
THANK YOU

The Rambam Health Care Campus